

Effects of home environment and lifestyles on prevalence of atopic eczema among children in Wuhan area of China

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Atopic eczema is a common health problem in children. The prevalence has increased in the past decades. Besides a genetic predisposition, lifestyle factors, dietary habits and indoor environments are thought to be related to its high prevalence. A cross-sectional questionnaire study was carried out in 2011 in the Wuhan area to study associations between home environments and children's health. The questionnaires were replied to by parents of 2193 children 1–8 years old and the response rate was 91.4% (2193/2400). The results show: (1) The prevalence of “eczema symptom ever that lasted for 6 months” was 23.2%; “eczema symptom in the last 12 months” 7.4% and “awake at night due to itchy rash” 3.4%. (2) Risk factors: Closer to business area (AOR 1.4), moisture related problems (AOR 1.3–2.2), moldy and stuffy odor perception (AOR 1.5), mice observed (AOR 1.8), pet keeping (AOR 1.3), exposure to environmental tobacco smoke (AOR 1.3) and incense (AOR 1.8) were significant risk factors for atopic eczema symptoms ever. Living in an apartment, compared to single family house, was related to more eczema symptom in the last 12 months. Damp clothing/bed sheets and perception of stuffy odor were risk factors for both “eczema symptom in the last 12 months” and “awake due to itchy rash (severe eczema)”. The odds ratio of mice observed for severe eczema was 3.1 (95% CI: 1.4–6.7). It suggests that urbanization, life style and dampness problems at home were significant risk factors for eczema symptoms among children in Wuhan, China.

children, eczema, home environment, building characteristics, dampness, indoor air quality

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Atopic eczema (also referred to as atopic dermatitis) is an inflammatory skin disorder characterized by itching that has a predilection for the flexures, as for example, anterior elbow and posterior knee. It is the most common inflammatory skin disease in children, with a current prevalence of approximately 10% in developed nations [1–3]. Although atopic eczema is not life threatening, the constant scratching associated with atopic eczema may result in skin damage, secondary infection, and sleep loss to both child and parents. It has huge economic implications for health services and

individual budgets [4]. Like other atopic diseases such as some asthma and hay fever, the prevalence of atopic eczema has increased substantially over the last 30 years, for reasons largely unknown [5,6]. Although a genetic predisposition to the disease has been implicated, evidence from a range of sources suggests that environmental and lifestyle factors play a crucial role in the disease expression [7]. In a Korea study, atopic eczema of children 6–13 years old was found to be highly correlated with environmental tobacco smoke (ETS), especially among children whose mothers had smoked during pregnancy and/or in the first year after birth [8]. An epidemiological study in Germany reported

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associations between atopic eczema and animal contact, use of gas without ventilation and living near a road with heavy traffic [9]. High indoor humidity and moisture may provide an environment for house dust mites, which are a well-known cause of atopic eczema. In Finnish and Swedish studies, significant association between atopic eczema and visible mould and/or damp stains was reported [10,11]. The prevalence of atopic diseases in developing countries has been shown to be subject to dramatic increases as traditional lifestyles are eroded by increasing adaptation to the living patterns of industrialized societies [12].

In the last 40 years, China has experienced rapid urbanization. High rise buildings have and continue to replace one-story houses. Synthetic furnishing materials are used more often in dwellings. Decreased air circulation because of better insulation may increase the risk of eczema by contributing to increased dust mite populations. But in China, epidemiological studies of the prevalence of eczema in children are rare, and etiological epidemiological studies on eczema are even fewer. In order to characterize the associations between home environmental factors and Chinese children's health, the China, Children, Homes, Health (CCHH) study, a national population-based project, has been carried out in Beijing, Shanghai, Chongqing, Wuhan and other cities. The present study is part of the CCHH project. The aims of the present study were to quantify the prevalence of eczema among children in the Wuhan area, and to characterize the local home environmental factors that are associated with this disease.

1 Subjects and methods

1.1 The questionnaire

This investigation was a questionnaire-based epidemiological study which was carried out from April to May 2011 in the Wuhan area, China. The questionnaire was similar to questionnaires used in the Swedish DBH and the Bulgarian ALLHOME study [13,14], with small modifications of questions on building characteristics. The original questionnaire has also been used in Denmark, South Korea, Singapore and USA. The wording for atopic eczema symptoms are from the ISAAC study [15], as shown in Table 1. "Keeping awake at night due to the itchy rash" is defined as severe eczema. Questions on life style and home environmental factors consist of: (1) Building characteristics: residential location; surrounding environment; house type; house size; building age; house ownership; ventilation and heating system; window type; floor and wall covering; housing renovation before and after child was born; (2) Moisture related problems: visible mold or damp on walls, ceilings and floors; previous or present flooding; condensation on windowpane in winter; damp stains on clothing/bed sheets; perception of odors; (3) Lifestyle related factors:

Table 1 Questions on eczema symptoms used in CCHH study

Question number	Description
1a	Has your child ever had an itchy rash that was coming and going for at least 6 months?
1b	When did this itchy rash first occur? (Before 1 year; 1–2 years; 3–4 years; after 4 years)
2	Has this itchy rash affected any of the following places: the folds of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears, or eyes?
3	Has your child had this itchy rash at any time in the last 12 months?
4	In the last 12 months, how often, on average, has your child been kept awake at night by this itchy rash? (never in the last 12 months; less than 1 night per week; 1 or more nights per week)

breast feeding, daycare attendance, exposure to environmental tobacco smoke; room cleaning and window opening (for ventilation) frequencies; sun-dry clothing/bed sheets; use of incense; children's outdoor activities.

1.2 Study subjects

Questionnaires were distributed to parents with children 1–8 years old through kindergartens and primary schools. One randomly selected kindergarten and three primary schools were invited to join the study. On-site meetings were arranged between parents, school teachers and investigators to distribute questionnaires. On the next day, completed questionnaires were returned to school teachers. Parents of 2400 children were involved. This study was approved by the Office of Scientific Research Management of Huazhong Normal University.

1.3 Statistical methods

The effects of lifestyle and environmental factors on atopic eczema were analyzed by a *Chi*-square test. Significance is indicated by a *P* value less than 0.05. For those factors that reached significance, odds ratios were calculated in logistic regression models adjusted for gender, age and family allergic history. All statistical analyses were performed with the SPSS, version 17.

2 Results

2.1 Characteristics of study children and the prevalence of symptoms

In total, parents of 2193 children responded to questionnaires, giving a response rate of 91.4%. Questionnaires were mostly filled out by mothers (64.6%). Table 2 presents personal characteristics of 2193 children, including their ages, gender, and family allergic history. Table 3 presents

Table 2 Demographic information of children 1–8 years old in Wuhan area, 2011

Personal characteristics	Number (%)
Age	
Less than 5 years old	123 (5.6)
5–8 years old	2070 (94.4)
Gender	
Male	1156 (52.7)
Female	1037 (47.3)
Family allergic history	
Yes	361 (16.9)
No	1769 (83.1)

the prevalence of atopic eczema symptoms. It shows that boys had more eczema symptoms and reported this itchy skin symptom at a younger age compared to girls.

2.2 Statistical analyses for different exposure factors

Associations between building characteristics, dampness index, life style and eczema among children were analyzed by *Chi-square* test, as shown in Table 4. For eczema symptoms ever, significant risk factors were close proximity to business area, moisture related problems, stuffy and/or moldy odor, perception of cockroach and/or mice, exposure to tobacco smoke or incense, and pet keeping. With regard to current eczema symptoms in the last 12 months, more symptoms were reported in apartments, compared to single family houses. Dampness problems, especially damp clothing and/or bed sheets were consistent risk factors for both eczema ever and currently. Severe eczema (i.e. keeping awake at night due to itchy rash) in the last 12 months was associated with close proximity to an industrial area, flooding in dwellings, damp clothes and/or bed sheets, perception of stuffy and/or moldy odor, observation of mice.

2.3 Logistic regression for children's eczema

Factors which had a significant association with influence

on atopic eczema (see Table 4) were analyzed in logistic regression models with adjustment of gender, age and family allergic history, as shown in Table 5. The adjusted odds ratios of dampness problems for eczema ever were 1.3–2.2. Stuffy smell was a risk factor for both eczema ever and current, with odds ratios from 1.5 to 2.2. Observation of mice and rates was a significant risk factor for severe eczema with odds ratio as high as 3.1. Indoor tobacco smoke exposure had an odds ratio of 1.3 (95% CI: 1.0–1.6). With regard to external environmental exposures, close proximity to an area with heavy traffic or pollutants (e.g. highway, industrial/business area) was associated with increased to an increment of eczema prevalence.

3 Discussions

For the first time, the prevalence of eczema symptoms and their associations with home environmental and lifestyle factors in Wuhan area have been documented. The questions on atopic eczema in our study are from the ISAAC study [15], which has been validated in previous worldwide studies [12]. Most of the previous surveys of atopic eczema prevalence have been conducted in Northern Europe [2]. Our study shows that the prevalence of eczema in the hot Wuhan area is 23%. This prevalence is as high as those in parallel studies in Sweden (23%) and US (20%) [11,16], and suggests that atopic eczema is a major public health problem in Wuhan area.

It has been argued that the aetiology of atopic eczema is unlikely to be simple or uni-causal and that an understanding of the relationship between the disease and behavior, lifestyle, home and external environmental factors is crucial [17,18]. Some previous studies considered atopic eczema to be more common where breastfeeding period is short and the consumption of formulas, dairy products, eggs, fish and tomatoes starts early [1]; while others did not reveal protective effect from prolonged breastfeeding [19]. In this study, breastfeeding less than 3 months was related to a higher prevalence of current eczema symptoms, even though not significant. Exposure to ETS was a risk factor for eczema

Table 3 Prevalence of atopic eczema symptoms among children 1–8 years old in Wuhan, 2011

Symptoms	Total, % (n)	Stratified by the gender of child, % (n)		
		Male	Female	P ^{a)}
Eczema ever	23.2 (499)	25.7 (292)	20.4 (207)	0.003
Starting age of eczema				
Prior to 1 year of age	11.8 (254)	13.7 (156)	9.6 (98)	0.003
1–2 years of age	4.4 (94)	4.7 (53)	4.0 (41)	0.467
3–4 years of age	3.7 (79)	3.5 (40)	3.8 (39)	0.699
After 4 years of age	5.8 (124)	6.6 (75)	4.8 (49)	0.075
Eczema current	7.4 (181)	8.2 (93)	6.7 (68)	0.183
Severe eczema current	3.4 (73)	3.4 (38)	3.5 (35)	0.905

a) P value in Pearson *Chi-square* test.

Table 4 Effects of home environmental factors and lifestyles on atopic eczema symptoms among children 1–8 years in Wuhan, 2011

Environmental factors and lifestyles	Eczema ever		Eczema current		Severe eczema current	
	% (n)	<i>P</i> ^{a)}	% (n)	<i>P</i> ^{a)}	% (n)	<i>P</i> ^{a)}
Dwelling location						
City	23.5 (362)	0.693	8.0 (124)	0.123	3.1 (47)	0.148
Suburb and Country	22.7 (137)		6.1 (37)		4.3 (26)	
Environment surrounding dwelling						
Highway	22.1 (139)	0.418	9.3 (59)	0.035	2.9 (18)	0.335
Business area	27.2 (161)	0.007	6.5 (39)	0.288	4.1 (24)	0.356
Industry area	25.5 (12)	0.705	14.3 (7)	0.067	10.6 (5)	0.007
House type						
Single and detached house	23.3 (173)	0.807	5.5 (41)	0.005	2.7 (20)	0.469
Apartment	22.8 (259)		9.0 (102)		3.3 (37)	
Fuels for cooking						
Electricity	23.9 (69)	0.558	7.6 (22)	0.805	4.6 (13)	0.090
Gas	22.3 (278)		8.0 (100)		2.7 (33)	
Exhaust fan in bathroom						
Yes	23.1 (337)	0.796	7.7 (113)	0.586	3.2 (46)	0.365
No	23.6 (155)		7.1 (47)		4.0 (26)	
Visible mold/damp spot						
Yes	37.2 (94)	0.000	9.1 (23)	0.036	4.9 (12)	0.128
No	20.6 (354)		7.3 (127)		3.0 (52)	
Flooding						
Yes	29.8 (68)	0.006	10.6 (24)	0.073	5.8 (13)	0.024
No	21.7 (382)		7.2 (128)		3.0 (52)	
Condensation						
Yes, ≤5 cm	22.3 (282)	0.007	8.0 (102)	0.253	3.7 (47)	0.320
Yes, >5 cm	29.4 (97)		10.0 (33)		4.9 (16)	
Damp on clothing/bed sheets						
Yes	26.8 (22.6)	0.001	9.5 (81)	0.004	4.7 (39)	0.006
No	20.6 (261)		6.2 (79)		2.5 (31)	
Stuffy smell						
Often	27.7 (230)	0.000	10.1 (84)	0.001	5.1 (42)	0.002
Sometimes/never	19.7 (229)		5.9 (69)		2.4 (28)	
Moldy smell						
Often	30.2 (104)	0.001	7.5 (26)	0.863	6.1 (21)	0.003
Sometimes/never	21.7 (346)		7.8 (125)		2.9 (46)	
Observe cockroach						
Always or often	30.1 (49)	0.027	12.0 (20)	0.032	5.0 (8)	0.270
Sometimes or No	22.4 (402)		7.3 (132)		3.3 (59)	
Observe mice and rats						
Always or often	34.9 (29)	0.006	11.9 (10)	0.148	9.8 (8)	0.002
Sometimes or No	22.1 (398)		7.6 (137)		3.2 (58)	
Breastfeeding						
< 3 months	22.7 (128)	0.868	8.5 (48)	0.348	3.9(22)	0.281
≥ 3 months	23.0 (304)		7.2 (96)		3.0(39)	
Sun-dry clothing/bed sheets						
Often	22.7 (349)	0.602	7.4 (114)	0.387	3.5(53)	0.853
Sometimes/never	23.9 (105)		8.6 (38)		3.7(16)	
Current pet keeping						
Yes	27.0 (109)	0.031	8.9 (36)	0.254	3.8(15)	0.711
No	22.0 (380)		7.2 (125)		3.4(58)	
Use of incense						
Often	35.9 (23)	0.013	11.1 (7)	0.242	4.7(3)	0.517
Sometimes or No	22.6 (452)		7.2 (145)		3.2(64)	
Environmental tobacco smoke						
Yes	25.1 (308)	0.010	7.6 (93)	0.805	3.6 (44)	0.584
No	20.4 (181)		7.3 (65)		3.2(28)	

a)*P* value in Pearson *Chi*-square test.

Table 5 Odds ratios of home environmental factors and lifestyles for eczema (adjusted for gender, age and family allergic history)

Environmental factors and lifestyles	Eczema ever	Eczema current	Severe eczema current
Environment surrounding dwelling			
Business area (ref: No)	1.36 (1.09,1.70)		
Highway(ref: No)		1.39 (0.98,1.96)	
Industry area (ref: No)			2.77 (0.96,7.98)
House type			
Single and detached house		1.00	
Apartment		1.53 (1.05,2.25)	
Visible mold/damp spot			
Yes	2.16 (1.62,2.88)	1.21 (0.75,1.94)	
No	1.00	1.00	
Flooding			
Yes	1.38 (1.00,1.88)		1.78 (0.93,3.40)
No	1.00		1.00
Condensation			
Yes,≤5cm	1.00		
Yes,>5cm	1.35 (1.02,1.78)		
Damp on cloth			
Yes	1.32 (1.07,1.63)	1.53 (1.10,2.12)	1.94 (1.19,3.16)
No	1.00	1.00	1.00
Stuffy smell			
Often	1.52 (1.23,1.89)	1.76 (1.26,2.47)	2.19 (1.34,3.59)
Sometimes/never	1.00	1.00	1.00
Moldy smell			
Often	1.49 (1.14,1.95)	0.92 (0.59,1.44)	1.99 (1.16,3.43)
Sometimes/never	1.00	1.00	1.00
Observe of cockroach			
Always or often	1.36 (0.95,1.95)		
Sometimes or No	1.00		
Observe of Mice and Rats			
Always or often	1.75 (1.09,2.82)		3.07 (1.41,6.68)
Sometimes or No	1.00		1.00
Current pets keeping			
Yes	1.30 (1.01,1.68)		
No	1.00		
Use of incense			
Often	1.78 (1.05,3.02)		
Sometimes or No	1.00		
Environmental tobacco smoke			
Yes	1.27 (1.03,1.58)		
No	1.00		

symptoms (AOR 1.3), which confirms the findings in a Korea study [8].

With urbanization in developing countries, people move from country to city and from one-story single family house to high rise buildings with better insulation. Cities are characterized by heavy traffic and busy commercial areas. In a Bavarian study, residence closer than 50 m to a major road was an independent risk factor for atopic eczema [20]. Atopic eczema has also been shown to be an increasing problem in urban Nigeria [21]. The peri-urban environment of Lima was associated with 2.6-fold greater odds (95% CI: 1.3–5.3) of allergic disease [22]. In Wuhan, close proximity to a business zone, highway, or industrial area was a risk factor for eczema symptoms, with odds ratios of 1.4–2.8. People living in an apartment reported eczema in the last 12 months to be 1.5 times greater than those in a single family house. Moreover, modern life and home environments are characterized by greater use of central air conditioning sys-

tem, increased close contact with pets and decreased air circulation because of better insulation. In Wuhan, the typical ventilation system in residential buildings is natural ventilation through windows or doors. The use of exhaust fans in the bathroom did not have a significant influence on eczema symptoms. Pet-keeping was a strong risk factor for eczema ever, consistent with previous studies in Sweden and Germany [9,23].

The results of this study demonstrates that an unfavorable indoor climate, especially visible molds in the child's room and damp spots on clothing/bed sheets, which is known to be associated with allergic sensitization and respiratory allergy, also correlates with atopic eczema. Indoor high humidity may provide a suitable climate for dust mite propagation. A German study found that the prevalence of signs of moisture problems correlated significantly with the measured exposure to house dust mite allergens [24]. House dust mite allergen is a well-known contributor to the etiol-

ogy of atopic eczema. A high mite allergen level was significantly associated with an increased risk of atopic eczema among children in Japan [25] and in Germany [24]. Therefore, avoiding humid indoor climate might reduce the prevalence of atopic eczema. Sun-drying damp clothing/bed sheets was non-significantly related to less eczema. While better insulation of modern buildings may decrease energy loss, it also decreases air circulation. Insufficient air exchange rate cannot efficiently remove indoor pollutants or extra moisture from such tight buildings. Condensation on window panes in winter, as well as stuffy smell perception indoors, is a proxy for less ventilation [26]. These two factors were associated with an increase in both past and current eczema symptoms in Wuhan study. Further studies on ventilation and dampness in Wuhan homes are needed.

In summary, lifestyle factors, namely using incense, living in an apartment, breastfeeding less than 3 months and parents' smoking at home were associated with an increased prevalence of atopic eczema in children 1–8 years in Wuhan area. Moisture related problems in home environment were significant risk factors (adjusted odds ratios 1.3–2.2) for atopic eczema. Finally, the odds ratio for eczema from stuffy smell perception, an indicator of less ventilation, was associated with increased eczema ever, current eczema and severe eczema symptoms in the last 12 months.

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